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(54) **VARIABLE CAPACITANCE SENSORS AND METHODS OF MAKING THE SAME**

(75) Inventors: **Stefan H. Gryska**, Woodbury, MN (US);
Michael C. Palazzotto, Woodbury, MN (US)

(73) Assignee: **3M Innovative Properties Company**,
St. Paul, MN (US)

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(58) **Field of Classification Search**

USPC 257/E21.351; 438/171, 190, 210, 239, 438/244, 250, 381, 393

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,603,372 A 7/1986 Abadie et al.
5,135,691 A * 8/1992 Hama et al. 264/624

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1257052 A 6/2000
CN 1321243 A 11/2001

(Continued)

OTHER PUBLICATIONS

Budd, Peter M., et al., *Polymers of intrinsic microporosity (PIMS): robust, solution-processable, organic nanoporous materials*, Chem. Commun., 2004, pp. 230-231.

(Continued)

Primary Examiner — Asok K Sarkar

(74) *Attorney, Agent, or Firm* — Bradford B. Wright

(57)

ABSTRACT

A variable capacitance sensor includes a first conductive electrode comprising electrically interconnected first conductive sheets; a second conductive electrode comprising electrically interconnected second conductive sheets, wherein the first conductive sheets are at least partially interleaved with the second conductive sheets, and wherein the second conductive electrode is electrically insulated from the first conductive electrode; and microporous dielectric material at least partially disposed between and contacting the first conductive sheets and the second conductive sheets. A method of making a variable capacitance sensor by replacing ceramic in a ceramic capacitor with a microporous material is also disclosed.

8 Claims, 2 Drawing Sheets

